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NOTES ON SOME ITEMS INVOLVED IN CHECKING CONTRACT SPRAY PLANES

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In the process of inspecting contractor's spray planes for a control job it is necessary to (1) calculate the flow rate required for the desired application rate, (2) determine the flow rate of planes being used, and (3) check the adequacy of dump valves and spray tank vents.

There are of course many other items involved in a complete inspection job, but only the three points mentioned above are included in the following discussion.

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Flow Rate Calculations

Two formulas commonly used to calculate flow rate required from spray planes are:

$$F = \frac{SWD}{495} \text{ or } F = .00202\ SWD$$

When:

F = flow rate required in gallons per minute

S = speed of plane in miles per hour

W = width of swath in feet

D = application rate in gallons per acre

The $\frac{1}{495}$ or .00202 is a constant representing the portion of an acre covered in 1 minute at 1 mph with a swath width of 1 foot.

For all practical purposes and to simplify the calculations in the formulas above, 500 may be substituted for 495 and .002 for .00202. This simplification decreases the flow rate by only one percent which is insignificant. As simplified these formulas become:

$$F = \frac{SWD}{500} \text{ or } F = .002SWD$$

Example - Determine the flow rate required to apply 1 gallon per acre over a swath width of 500 feet from a plane flying 150 mph.

$$F = .002 \times 150 \times 500 \times 1$$

$$= 150 \text{ gpm}$$

Occasionally a spray plane will come on the job with pumping equipment which will not deliver the required flow rate. In such cases the flow rate of the plane is inserted in the formula as a known factor and the swath as unknown to determine the swath width to assign to the plane. For example, assume a DC-3 would normally be allowed a 500-ft. swath. At 150 mph for 1 gpa the flow rate should be 150 gpm. A calibration check shows that this plane will deliver only 120 gpm. The swath width must then be reduced. To determine the new swath width we calculate:

$$F = .002SWD$$

$$\text{then, } 120 = .002 \times 150 \times W \times 1$$

$$120 = .300W$$

$$W = \frac{120}{.300}$$

$$= 400 \text{ feet, the new swath}$$

Calibration Procedure

The object of the calibration procedure is, of course, to determine the flow rate of the plane. The first requirement is to make certain that the pump is primed and liquid lines are filled. Particularly in large planes, the tanks may be shaped or located so that the spray will not all drain down into the pump. Instances have been noted where a plane has a deadhead load of as much as 100 gallons.

To insure proper priming of the spray system (1) put sufficient liquid in the tank to prime the pump (2) take off and fly the plane in a straight and level flight at normal speed (3) open the spray valve and as soon as the spray pressure starts to drop immediately close it to prevent air being drawn into the system, and (4) land the plane.

Following this (1) meter into the tank sufficient liquid to provide a spray time of at least two minutes (2) again in flight leave the spray valve open until the pressure starts to drop, recording the "open valve time" with a stop watch, and (3) calculate gallons per minute by the formula:

$$\text{gpm} = \frac{\text{gals. metered into tank}}{\text{"open valve" time in minutes}}$$

For example, 210 gals, were metered into the tank and 3 minutes of "open valve" time were recorded. The flow rate was

$$\frac{210}{3} = 70 \text{ gpm.}$$

If the flow rate is within 5 percent of that desired it is usually not practical to make changes. Duplicate measurements should be made if time permits.

When the spray pump is driven by a gasoline engine the calibration may be carried out on the ground. With wind or hydraulic drives the plane should be flown to insure that full pump pressure is attained. Some hydraulic drives may permit ground procedure but usually not.

These preliminary measurements should always be verified on the job by timing with a stop watch the spray time required for a full load of spray. This can be done most accurately using the second plane load of spray rather than the first to insure that the system is primed and "dead-head" load, if any, established. Flow rate checks should be made as the control job progresses to discover any changes in adjustment of pressure, clogged nozzles, etc. The full load calculation is preferred over limited load when conditions permit.

If the flow rate is too high, some nozzles should be removed. When it is too low, nozzles should be added. If pump capacity is limited or the booms are too small to carry the gallonage without high friction losses, the addition of nozzles may not increase the flow. In these cases the swath must be reduced to conform to flow rate.

Dump Valves and Tank Vents

Emergency load dumping devices are required in control contracts. The size is usually specified as a ratio between load in gallons and area of dump valve in square inches. In 1957 in Region 1, it was 7.65 to 1 for single-engine planes and 9.6 to 1 for multi-engine planes. If a plane does not meet the specification the load should be reduced to conform to the area.

For example, a multi-engine spray plane has a tank capacity of 1,000 gals. and a dump valve area of only 80 sq. in.

$$\frac{9.6}{1} = \frac{L}{80}$$

$$L = 9.6 \times 80$$

$$= 768 \text{ gals., the allowable load.}$$

Tanks must be adequately vented so as not to restrict the flow through the dump valve. On the basis of tests with a Stearman having a 5-in. diameter dump valve, with 150 gallons in the tank, a $1\frac{1}{4}$" diameter thin wall tubing vent was restrictive. The dump rate was 490 gpm. There was no restriction in the dump rate when a 1 3/4" o. d. tubing vent was used. The dump rate then was 600 gpm.

Using the above data it appears that a ratio of area of dump valve in sq. in. to area of vent in sq. in. should be not greater than 9 to 1. Although no tests have been made with large tanks, ratios somewhat greater than this could be tolerated because the friction loss in large vents will not be directly proportional to that in small vents. There can be no firm rule on this until additional data are available. It can be determined whether or not the vent is restrictive by timing the dumping of a load of water on the ground with tank cap on and one with the cap off to give additional venting. On some planes the dump valve may be considerably larger than that required by the "load to dump valve area" ratio. In that case, the vent size should be based on the minimum dump valve area that would meet the specifications. There is a possibility that a greatly restricted vent could cause damage to the tank by the rapid changes in internal pressure.